Space Weather Technical Forecast

Issued on Thursday, 22 September 2022 at 01:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares (R1-R2 Radio Blackout). G1/Minor or G2/Moderate Geomagnetic Storm intervals expected day 2 (23rd). Active Electron Fluence following later day 3 and 4 (24th and 25th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Moderate over the past 24 hours, with an M1.1 flare from AR3107 at 20/0702 UTC, and a number of C-flares also observed. There are four numbered sunspot regions on the solar disc. AR3105 Dai/Beta in the southwest is the largest group on the disc, and has continued to see the emergence of small spots in its surrounding vicinity, although remains relatively stable. AR3107 Dac/Beta-gamma is a smaller region following AR3105, although the current analysis is low confidence due to its oblique viewing angle. AR3102 Eso/Beta has continued to decay as it approaches the southwest limb. AR3108 Cro/Beta is a small and simple region west of AR3105. No Earth-directed CMEs were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, has generally persisted at slightly elevated levels easing from 500 km/s to 450 km/s. Density was mostly at average levels. The total interplanetary magnetic field (IMF), Bt has been largely Weak, between 4-7nT. The north-south component Bz, fluctuated between -3 nT and +6 nT, and predominately positive (northward). The phi angle was mainly negative (towards the Sun), although it did briefly rotate into a positive (away from the Sun) sector 21/0900-1200 UTC. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, eased to be close to background levels. High energy electron flux (greater than 2 MeV) was at background to Moderate, with peak value 384 pfu at 20/1410 UTC. The associated 24 hour fluence remained well below the Active (1e8 integrated pfu) threshold. Observed fluence at 22/0000 UTC was 1.21e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low to Moderate with further C-flares and a chance of M-flares. The main flare risk is from AR3105 and AR3107 in the southeast disc.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Slightly elevated solar winds will gradually ease towards background day 1 (22nd), with the next enhancement, from the fast wind of CH25/+ expected day 3 (23rd). Generally Quiet geomagnetic activity with isolated Unsettled spells until early day 2. Activity then increasing to Active to G1/Minor Storms, with a chance for G2/Moderate Storm intervals. Conditions then easing to Quiet to Unsettled by day 4 (25th).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES-16, is expected to persist at background levels. The high energy electron flux (greater than 2 MeV) is expected to be at background to Moderate at first, before rising day 3 and day 4 (24th and 25th) in response to fast wind arrival from CH25/+, with persistently high flux expected by the end of the period. The associated 24-hr fluence is expected to stay below the Active (1e8

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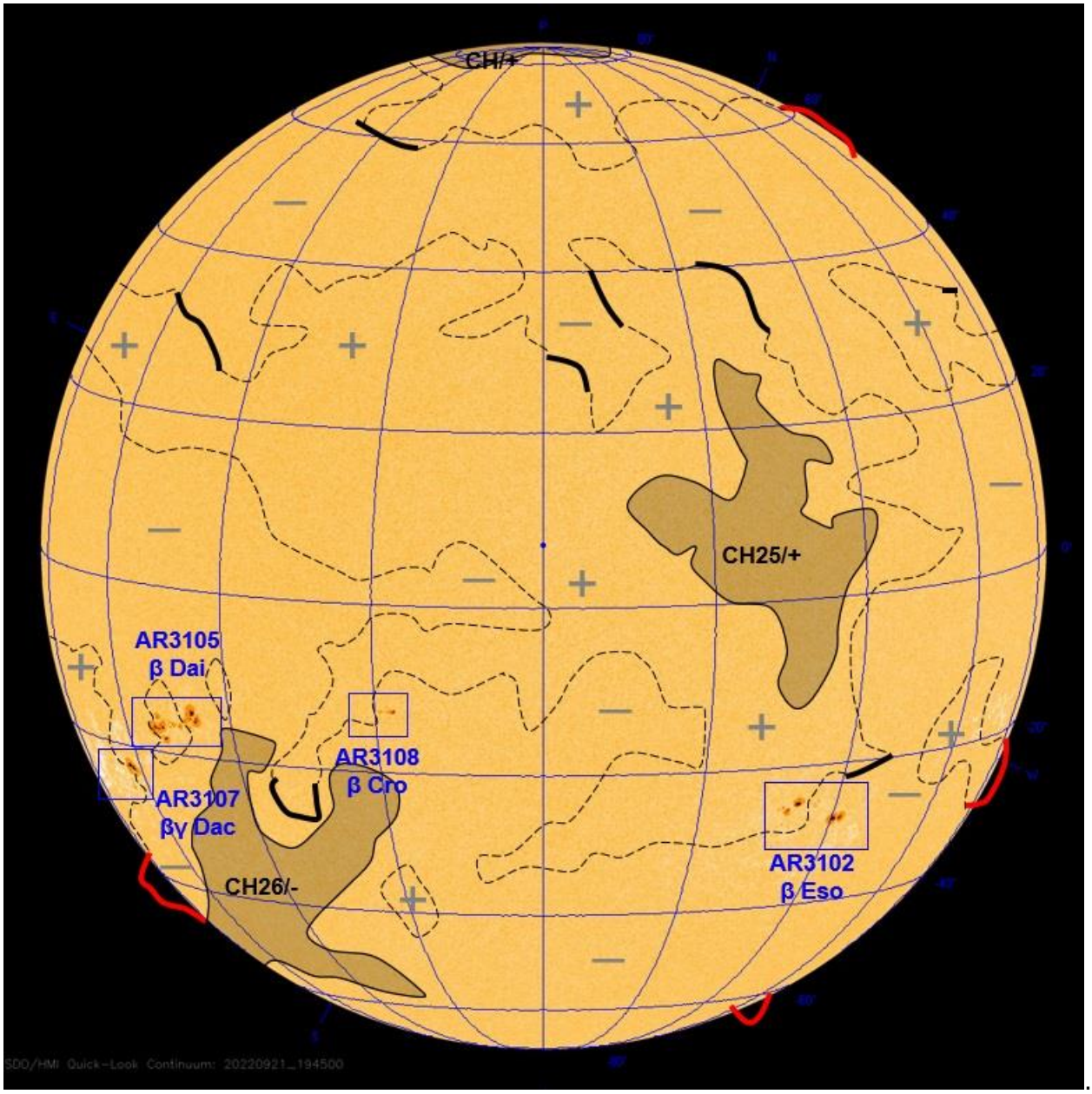
integrated pfu) threshold for much of the period, but likely rising above by the end of day 3 (24th).

Figure 1. Solar Analysis Valid 21/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

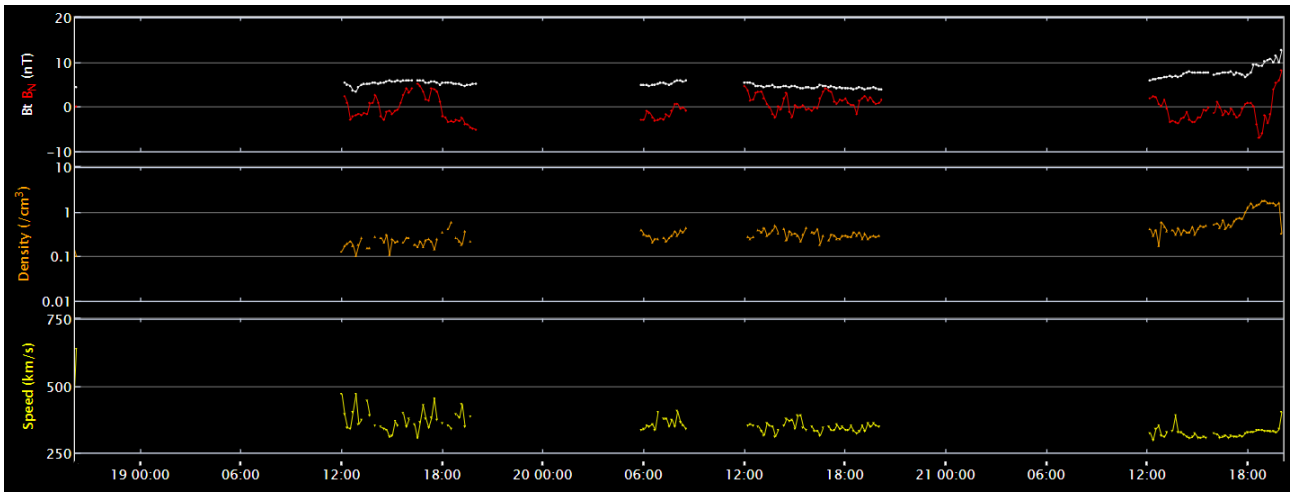
No Earth-directed CMEs have been observed.

Solar winds are currently easing from their slightly elevated levels, near 450 km/s, likely declining towards background through day 1 (22nd). The next enhancement will be from the arrival of the fast winds of CH25/+. This is a much larger and more well-defined feature on this rotation. However, observations at STEREO A, which samples the solar wind around 1.5 days before Earth, have yet to show a definitive arrival, perhaps indicating a potential CIR passage at time of issue. Consequently the arrival of these fast winds has been delayed until nearer midday on day 2 (23rd), likely rising to around 500-600km/s into day 3 (24th) before easing further.

Geomagnetic activity is expected to be generally Quiet with isolated Unsettled spells day 1 (22nd). Activity then increasing to Active to G1/Minor Storms, with a chance for G2/Moderate Storm intervals with the fast wind arrival, likely around midday on day 2 (23rd). Conditions then easing to Quiet to Unsettled by day 4 (24th and 25th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	70	30	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Solar Wind Observed at STEREO A (around 1.5 days before arriving at Earth). Enhancement late on the 21st (corresponding to early 23rd at Earth)



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Radio Blackouts - X-Ray Flares:

Solar activity is forecast to be Low to Moderate, with ongoing C-flares and a chance of further M-flares. There are four numbered sunspot regions on the Earth-facing disc.

The largest region is AR3105 Dai/Beta in the southeast disc. Despite the size of the region, with some ongoing limited flux emergence in its vicinity, this has maintained a relatively straightforward magnetic configuration. Along with its east-west alignment limiting any shear across its field lines, this region is likely to remain relatively stable although any flares that do occur have the potential to reach M-class, or perhaps approaching X-class.

AR3107 Dac/Beta-Gamma is a more complex but smaller region, closer to the southeast limb. The exact nature of this region remains hard to assess and very low confidence, with foreshortening prevent an accurate assessment of its magnetic structure. However, its more north-south aligned field suggests a greater chance for instability. AR3102 Eso/Beta in the southwest has continued to simplify and reduce in areal extent, whilst AR3108 Cro/Beta also in the southeast disc, west of AR3105, remains small with on very slight growth occurring.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES-16/17 X-ray Flux

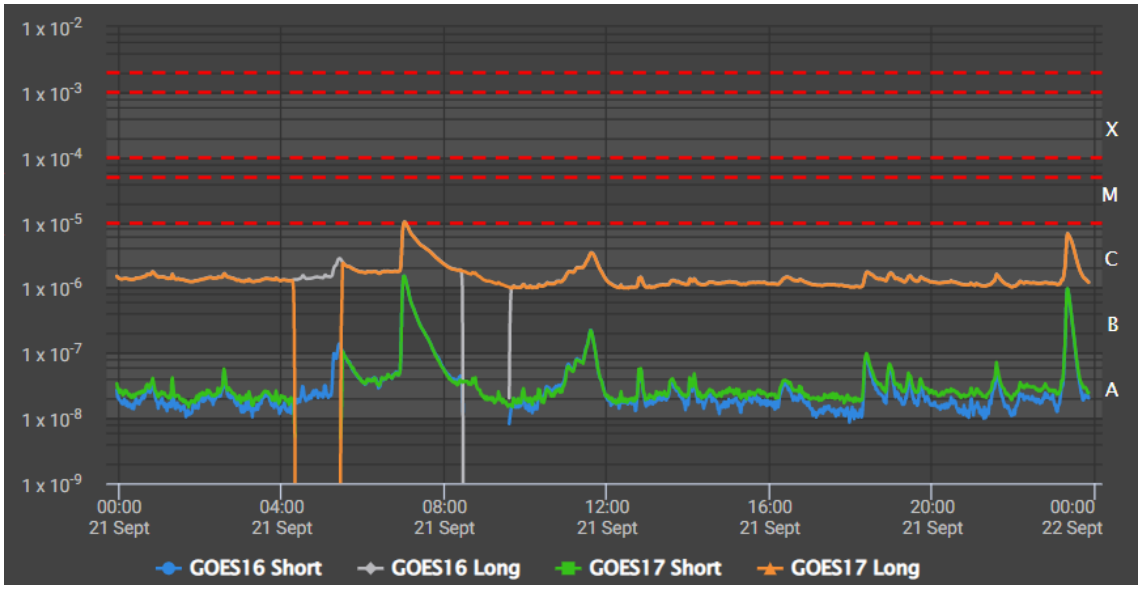

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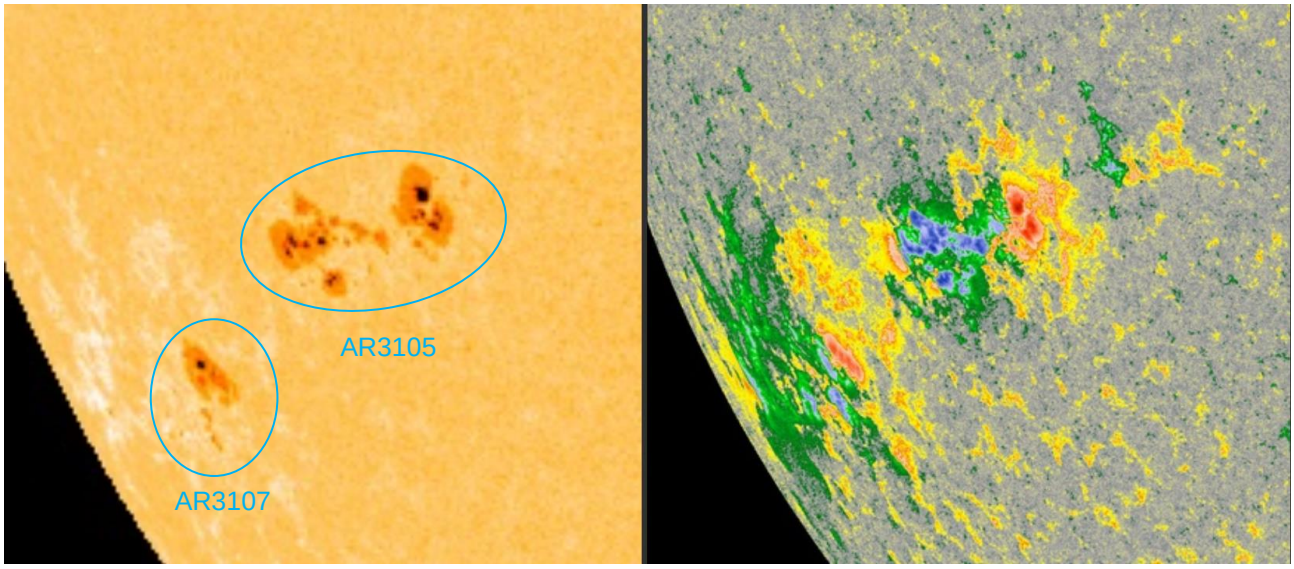
Figure 4: SDO hmi-intensitygram (left) and hmi-magnetogram (right) of SW disc. AR3107 is relatively small but with suggestions of a more complex magnetic field. AR3105 is larger, but in a relatively stable configuration.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) observed by GOES-16 is expected to remain close to background levels, with the main flare risk sunspots currently in the southeastern disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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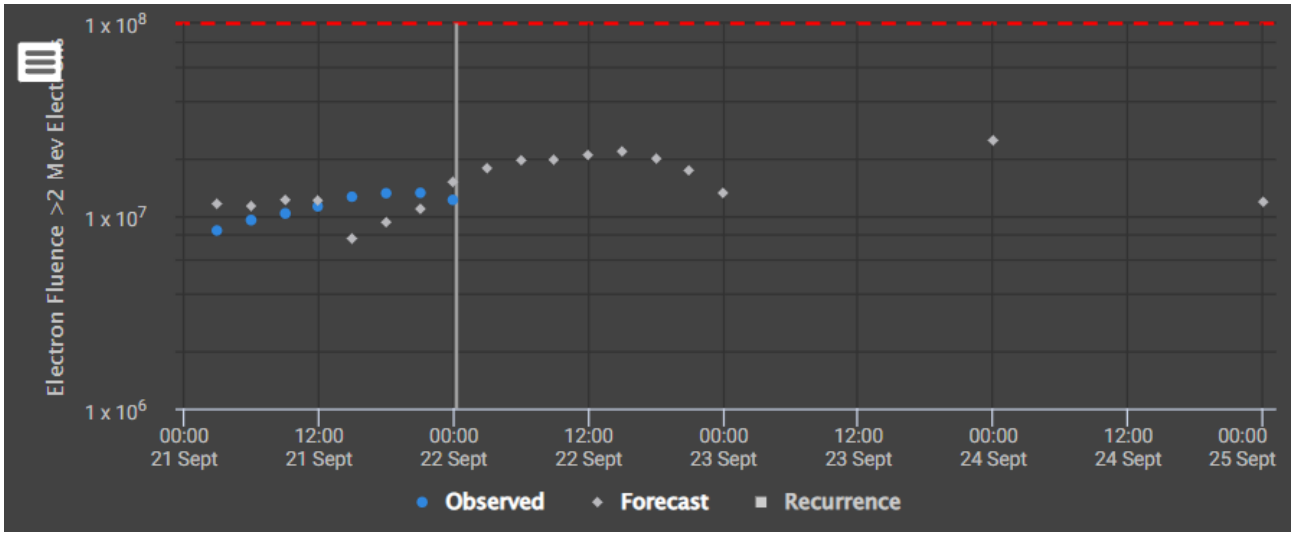
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) as observed by GOES-16, is currently Background to Moderate. The arrival of the fast wind of CH25/- on day 2 (23rd) is expected to enhance electron populations at Earth, with High flux levels likely to develop once any initial geomagnetic activity subsides, through days 3 and 4 (23rd and 24th).

The associated 24 hr fluence is expected to remain below the Active (greater than 1e8 integrated pfu) threshold until day 3 (24th), with REFM giving a good guide to current conditions and trends until at least day 2 (23rd). However the expected fast wind arrival is likely to be stronger than persistence suggests, limiting the models performance beyond this date. Increasing flux later days 3 and 4 (23rd and 24th) is likely to bring Active fluence by the end of the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	60	70
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	2	5

Figure 5: >2MeV Electron Fluence with REFM



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